# The Textile Show!

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| Affiliation and Location | Rewovenplanet (non-profit) and the Harker Upper School.. Our goal is to help students understand the importance of using algorithmic techniques to solve scientific problems related to sustainable textiles.<br>  License: Creative Commons License<br>https://creativecommons.org/licenses/by-nc/4.0/ |
| Lesson Plan Abstract | This lesson builds on two key concepts - Near Infrared Spectroscopy data, and python notebooks for analyzing this data and classifying fabrics using Machine Learning. Along the way, students also learn about the textile pollution problems worldwide, and are provided with resources to learn more. |
| Learning Objectives | Students will be able to:<br>• Explain the impacts of the textile pollution problem<br>• Explain NIRS and how to use the NIRS dataset.<br>• Appreciate the role of AI and data analysis in textile pollution mitigation |
| Grade Levels | Physical Science, Engineering, Math for Grade 8, 9, 10. The exercises assume knowledge of python. |
| Time | 2 45 minute periods (two periods can also be combined if used in a block schedule) |
| Resources Needed | Printed handouts for the discussion<br>One computer with a web browser and wi-fi access for every group of students. The code is available as Google colaboratory notebooks but can be downloaded and run in any Python IDE if the requisite packages are installed. The datasets are available on Google Drive. |
| Apps/Websites Needed | All the data is provided in Google Drive<br>All the analysis is done in Google Colab notebooks in Python.<br>Presentation in Google Slides.<br>All videos are online on youtube. The curriculum videos were made by Rewovenplanet AI4Science and available on the AI4Science youtube channel (links to each video are below). The slides, background references and code are available on Google. |
| Data Sources | The dataset was custom gathered in collaboration with SPECIM<br><br>For students and teachers interested in continuing further, https://rewovenplanet.org contains articles and a podcast. Larger versions of the data and more research tools will be posted there in the coming months. |

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## General Information

- Students can work in groups of 2-4 and can share a computer if needed
- The lessons are structured assuming that students may not know much about the textile pollution problem. There is an infographic that students can use to learn more and discuss.

# Part 1 Lesson Plan (1 modules, 45 min)

## The Textile Pollution Problem

Context and Framing the Problem. All about textiles!  (10 minutes)

- Play the textile introduction video or present slides
    - Video is here:  https://youtu.be/XS6CVZHtBoQ?si=w-vyfofMQ_hnoG5s
    - Slides are here:


    - https://docs.google.com/presentation/d/121upvWIACIgZHSdrelr7tVXgUU-OmDb2GfNQZndiElY/edit?usp=sharing
- Additional slides to review show why textile sorting is hard:
    - Slides are here:
    - https://docs.google.com/presentation/d/1fCKDvPpcgNqEvt2coOlgFbmcK-YMQ6ktt28Yu4zxQJs/edit?usp=sharing

Learn about Near Infrared Spectroscopy

- Play the introduction video **https://youtu.be/9eplCtwBbn8**
- Slides are here: https://docs.google.com/presentation/d/1UUe_uiJpmU4XyMP8053p8qac5DC0r6IOsev1ItipeTU/edit?usp=drive_link

Examine the dataset

- Play the video that introduces the dataset. **https://youtu.be/t6wq79aV5DY**
- Slides for the video are here: https://docs.google.com/presentation/d/13DQKzRHf6MAnldKf2ZiszUb6WcCDDC4dd1__bUnuyM4/edit?usp=drive_link
- There are two dataset files (NIRS_data.csv and NIRS_sampled_data.csv) - the smaller one is a 10% sample of the rows of the bigger one. The provided Python notebooks work on either.
- Small dataset is here: https://drive.google.com/file/d/1yVGsE8LnopyFWk7v8k37tg-4Jii18KQA/view?usp=drive_link
- Large dataset is here: https://drive.google.com/file/d/1SlKeDHH1CdLlYwYBHN6uszZMENlQ6JWh/view?usp=drive_link
- Students can then examine the dataset in any tool they find easy. We recommend starting with the smaller dataset, which can be explored in either python or Google sheets.

Discussion

- Why is this dataset hard to analyze?
    - It has a lot of columns (224)! The relationship between the columns are not obvious
    - The columns contain absorbance values for each wavelength - which is not intuitive for humans.
- What may we be able to learn from it?
    - We will try to learn how the patterns hidden in these values differ from fabric to fabric.

Step one of analyzing the data

- Use the provided python notebook to analyze and visualize the data. https://colab.research.google.com/drive/17wHLkcF2l7tbqDekX4LbTR6WhQD-Ix6C?usp=sharing

  Note: Students can just run each section of the notebook, even if they do not fully understand all of the python code. If they would like to skip coding entirely, they can also analyze the data in Google sheets (in this case we recommend the smaller dataset).

Discussion (5 min)

- How did the python code help us visualize the data? We can see patterns now that differentiate between the fabric types. We can also see where they are similar.

# Intermediate Assignment

Students can review the provided infographic (https://drive.google.com/file/d/1kSsp_3qW5TSgkcEdWsUyw5HXQ6ChPFWg/view?usp=drive_link) and answer the following questions

- What are the top 5 textile pollution problems, in your opinion?
- What is your state (or country) doing about the problem?
- Do you know where you can dispose of your used clothes safely?

# Part 2 Lesson Plan (1 module, 45 min)

## Module 2: Classifying Fabrics based on the data (45 min)

Note: This exercise assumes some basic knowledge of machine learning. If the students do not know this - the exercise can be skipped.

Students will explore the attached Colab notebook, which can be used to classify fabrics based on the dataset.

- The colab notebook is here: https://colab.research.google.com/drive/1WmfhM-xcyDwmIt8qAivupUeIOe74QdhI?usp=sharing

What's Next

- Play video that summarizes the work done in these two modules, and provides more resources.

# Future Project Ideas

Future projects - if students are so inclined

- Explore other analyses of the dataset.
- Explore the larger dataset, particularly regarding the classification of blends. Contact dan@gprof.com for access to the complete dataset. It will also be posted at https://rewovenplanet.org at some point in the future.
- Explore local initiatives for textile recycling in your communities.

# Variables and Definitions

| Term | Definition |
|---|---|
| Dataset | The data itself, usually in a table |
| Features | Columns of the dataset, which can be different types |
| Sample | A row in the dataset |
| Near Infrared Spectroscopy | A mechanism where light in the Near Infrared Spectrum shone on a fabric causes reflectance and absorbance indicating the chemical makeup on the material. |
| Pixel | Each unit of data in the fabric image. |
| Classification | An AI method to identify the class of fabric (in this case Cotton, Polyester or Nylon) by identifying patterns in the NIRS data. |

# Feedback

Please provide feedback here! https://forms.gle/HrsoxwCC3JXLb4296